Air Quality Monitoring

Feedlots, wastewater treatment ponds and lagoons northwest of Brooks, Alberta

Spring, summer and fall 2003 and summer and fall 2005 **Final Report**

Summary

Monitoring consisted of mobile surveys (MAML) and stationary samplers. MAML surveys collected 28 hours of data at seven different sites. These sites were less than 2 km downwind of various facilities and operations. Stationary samplers consisted of continuous and intermittent particulate samplers. These were setup to help evaluate the extent of fugitive emissions.

Ammonia (NH_3)

The highest one-hour average NH_3 concentration of 0.829 ppm was measured downwind of Lakeside feedlot. Concentration at all other sites were lower than 0.1 ppm. Elevated NH_3 concentration downwind of **Site 2** was likely due to emissions from animal waste.

Reduced Sulphur Compounds (TRS and H_2S)

Total reduced sulphur (TRS) during this study was almost entirely composed of hydrogen sulphide (H_2S). The maximum one-hour average H_2S concentration of 0.012 ppm measured downwind of wastewater treatment ponds and lagoons (**Site 3**) was substantially higher than that measured at the other sites. Furthermore, this concentration exceeded Alberta's Ambient Air Quality Objective (**AAAQO**) for H_2S (0.010 ppm). One-hour average concentrations at all other

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sites were lower than 0.003 ppm. Elevated TRS concentrations downwind of wastewater treatment ponds were likely due to anaerobic decomposition.

Polycyclic Aromatic Hydrocarbons (PAHs)

Elevated PAHs during this study was most probably due to emissions from motor vehicles on Hwy 1. The maximum one-hour average of 21 ng/m^3 was measured at **Site 4** just north of Hwy 1.

Total gas phase Hydrocarbons (THC)

THC notably higher than background concentration (~2 ppm) was measured downwind of Lakeside feedlot (3.5 ppm) and wastewater treatment lagoon (3.8 ppm). Downwind of wastewater treatment ponds and lagoons, elevated concentrations were measured concurrent with elevated NH_3 and H_2S. Elevated concentrations downwind of Lakeside feedlot was measured during low wind speeds (<8 km/hr). Elevated concentrations at these two sites were likely due to fugitive emissions from the respective facilities.

Particulate Matter

Particulate matter concentrations were generally higher during the 2003 survey; this was likely due to relatively dry conditions.

MAML

The highest TSP, PM_{10} and $PM_{2.5}$ were measured downwind of Brooks airport; concentrations for these parameters were 498, 395 and 65 ng/m^3, respectively. Elevated one-hour average PM_{10} (186 ng/m^3) and TSP (361 ng/m^3) concentrations were measured downwind of Lakeside feedlot. Elevated PM_{10} and TSP concentrations were possibly due to increased activities on the feedlot.

Other

Two out of the seven intermittent (filter) particle samples taken when feedlot odours were present exceeded the 24-hour AAAQO for TSP. PM_{10} concentrations showed similar variations as TSP. Increases in $PM_{2.5}$ were not observed during odour events. This implies that particles present when feedlot odours were evident do not have significant contribution to particles less than 2.5 micrometers ($PM_{2.5}$).

Introduction

Air quality monitoring northwest of the town of Brooks was initiated by concerns of fugitive emissions from feedlots, wastewater treatment lagoons and irrigation operations in the area. The largest of these facilities is Lakeside Farm Industry (which includes Lakeside feedlot). As an integrated agribusiness, Lakeside Farm Industry is involved in feeding, slaughtering, processing cattle, farming and irrigating land for silage. Previous surveys in the area[1] showed that the highest ammonia, hydrogen sulphide, hydrocarbons and particulate matter concentrations were measured downwind of Lakeside feedlot.

To assess the quality of air, Alberta Environment's mobile laboratory (MAML) and stationary particulate samplers were used to conduct air quality surveys. These unannounced surveys were performed during the spring, summer and fall of 2003 and summer and fall of 2005. There were three main objectives for monitoring in this area. They were: (1) quantification of fugitive emissions 2 km or less downwind of wastewater treatment lagoons, irrigation operations and feedlots, (2) exploration of the extent of fugitive emissions (particulate matter in particulate) further downwind (> 2km), and (3) comparison of measured concentrations to Alberta's Ambient Air Quality Objectives (**AAAQO**).

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[1] Air quality monitoring results from Town of Brooks and Taber and northwest of the town of Brooks (1998-2001)

Monitoring methods and locations

Monitoring had three components: (1) the department's mobile laboratory (MAML), (2) continuous monitoring of particles less than 2.5 micrometer (μm) in aerodynamic diameter ($PM_{2.5}$) and (3) intermittent filter based particulate sampling of two size ranges, PM_{10} (particles less than 10 μm in aerodynamic diameter) and total suspended particles (all particles less than 500 μm in aerodynamic diameter).

The MAML provides "snap shot" of the quality of air in time and space. It is equipped to simultaneously measure ammonia, carbon monoxide, hydrocarbons, oxides of nitrogen, ozone, particulate matter, reduced sulphur compounds and sulphur dioxide. Because of its mobile capabilities, the MAML was used to measure pollutants downwind of feedlots, lagoons and irrigation operations. The MAML sampled 2 km (typically less) downwind of these facilities and operations. Monitoring locations are indicated in Figure 1. A total of 28 hours of data was collected at seven different sites. A description of each site is given in Table 1. "Pivot" in Table 1 refers to the method of irrigation used in the area.

To evaluate the influence of particle emissions from feedlots further downwind, samples were taken using stationary samplers (**Site 8** and **9**). During the 2003 and 2005 monitoring periods, the continuous particle sampler Tapered Element Oscillating Microbalance (TEOM), measured $PM_{2.5}$ concentrations and provided one-hour averages. In addition, PM_{10} and TSP were collected using two Partisol samplers (filter based measurements). Partisol samples were located east of Lakeside Farm Industry (**Site 8**). Partisol sampling was intermittent; samples were collected when conditions were perceived to be poor (low wind speed, presence of odour and haze). Concentrations determined from these measurements were 24-hour averages. During the 2005 monitoring period, only the continuous particle sampler (TEOM) was used. For this period, a TEOM was located at **Site 9** due southwest from Lakeside Farm Industry.

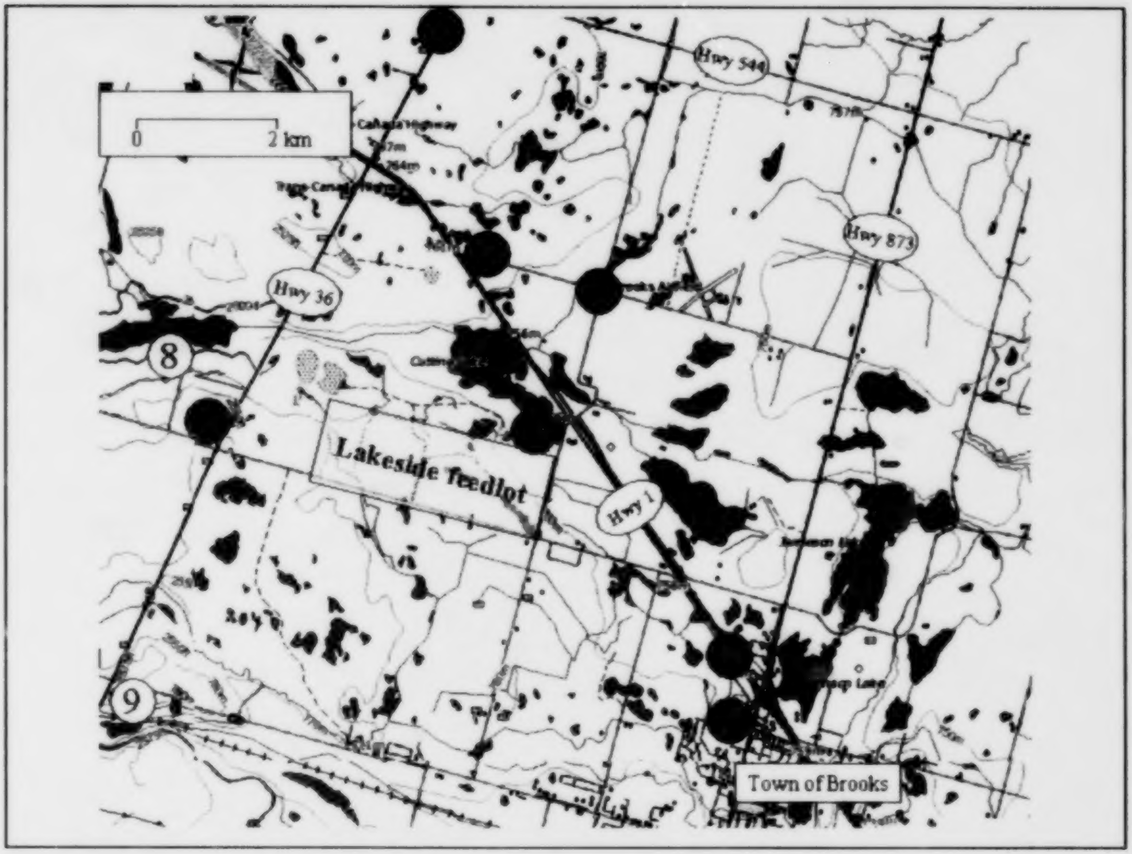
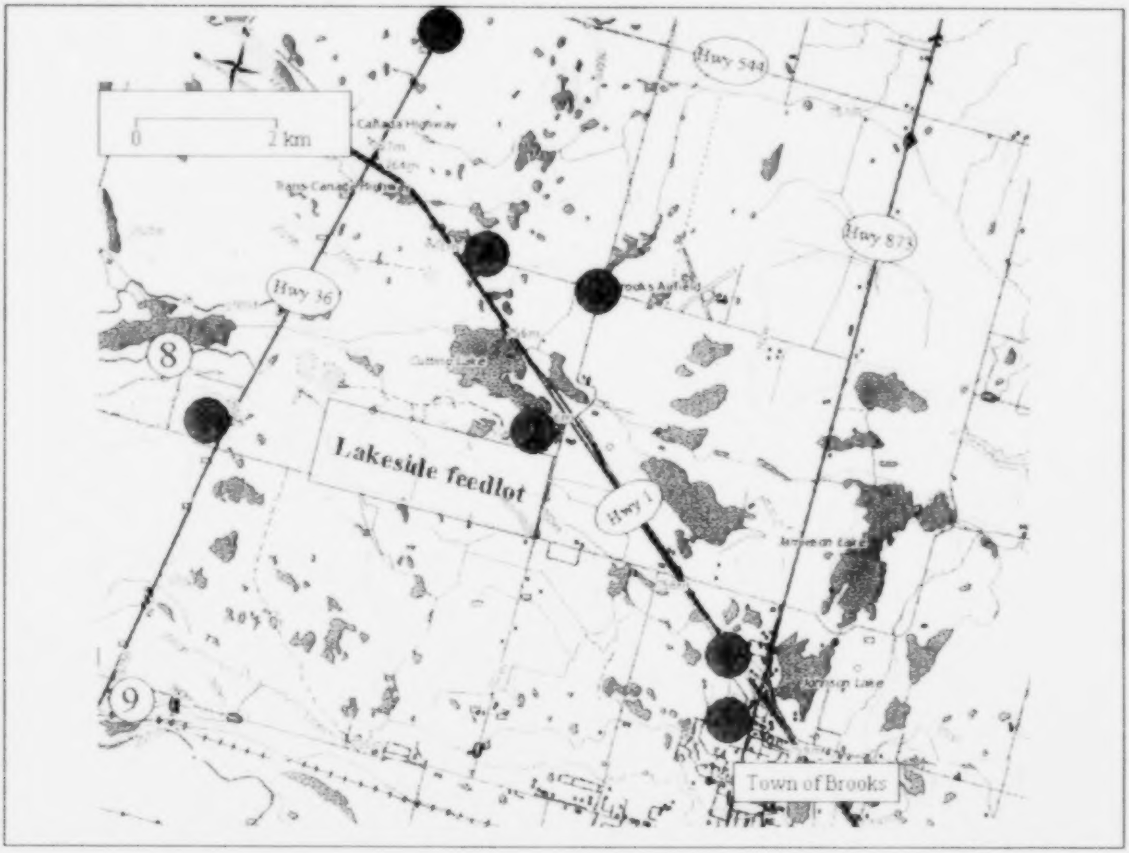


Figure 1: Map of monitoring locations, descriptions are given in Table 1.

Table 1: Description of monitoring sites

Site #	Description
1	Upwind, entrance to Paul Seaton residence (MAML)
2	Township road 192 and Range road 151, 20 meters from Lakeside feedlot fence line (MAML)
3	North of Peterson Lagoons and Lakeside wastewater treatment ponds (MAML)
4	1.5 km north of Lakeside feedlot (MAML)
5	400 meters downwind of Martin feedlot (MAML)
6	Downwind of Lakeside and Martin feedlots (MAML)
7	Downwind of North Eastern Irrigation District (EID) pivot (MAML)
8	Seaton residence (stationary particulate monitoring 2003 survey)
9	Luedtke residence (stationary particulate monitoring 2005 survey)



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Results and Discussion

In the following section, concentrations of pollutants relevant to the current study will be discussed. These include: ammonia, reduced sulphur compounds, hydrocarbons, polycyclic aromatic hydrocarbons and particulate matter. All the parameters measured by the MAML are presented in Table A1, A2 and A3 in Appendix A. In discussing the data collected using the MAML, the median[2] one-hour average and maximum one-hour average are presented. These allow the discussion of mid as well as the highest one-hour averages. In additions, these values were compared to Alberta's one-hour Ambient Air Quality Objectives (AAAQO). The key in Figure 2 illustrates how the median and maximum one-hour averages are represented in the following section. A number of the monitoring sites for the current survey (**Site 1 and Sites 5-7**) have a total sample period of one hour. Concentration presented for these sites will be a one-hour average.

[2] The median concentration is a common way of representing the central value for environmental data. Further discussion of the median value is presented in Appendix B

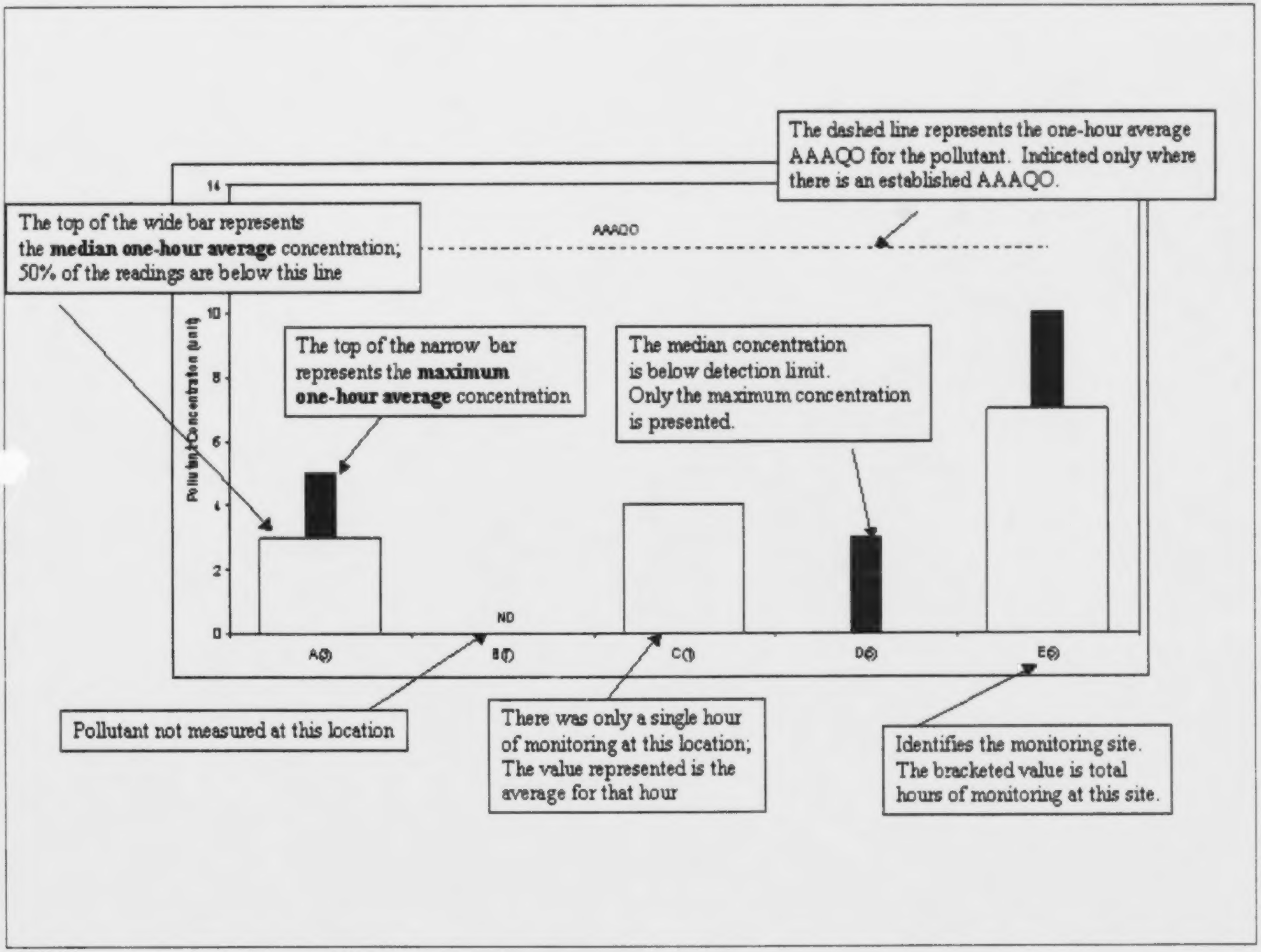

Figure 2: A key for interpreting graphical representations within this document.

Ammonia (NH_3)

Ammonia is produced by both natural and man-made sources. Decaying plant material is an example of natural NH_3 source. In Alberta, man-made sources of NH_3 include commercial feedlots (specifically from decaying animal waste) and synthesis and application of fertilisers. *Alberta has a one-hour Ambient Air Quality Objective of 2 parts per million (ppm).*

Figure 3 illustrates the range of NH_3 concentrations at the MAML monitoring sites. Concentrations at **Site 2** were substantially higher than those measured at all other stations. However, the maximum one-hour average concentration measured at this site (0.829 ppm) did not exceed Alberta's one-hour Ambient Air Quality Objective (**AAAQO**). The median one-hour NH_3 concentration at **Site 2** was 0.627 ppm. **Site 2** was located downwind of Lakeside feedlot; decay of animal waste is the most likely source of elevated NH_3 at this site. Comparatively, the one-hour average NH_3 concentration at the upwind site (**Site 1**) was 0.001 ppm. The median one-hour average NH_3 concentrations for recent MAML surveys were comparable to that measured at **Site 1** (Table A5), the exceptions were Whitecourt[3] and Girouxville[4]. The highest NH_3 concentrations in a previous study in the area[1] was also measured downwind of Lakeside feedlot, albeit the maximum concentration for that study was higher at 1.4 ppm.

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[3] Monitoring in an area where pulp mill sludge spreading was taking place

[4] Monitoring in the vicinity of confined feeding operations [illegible]

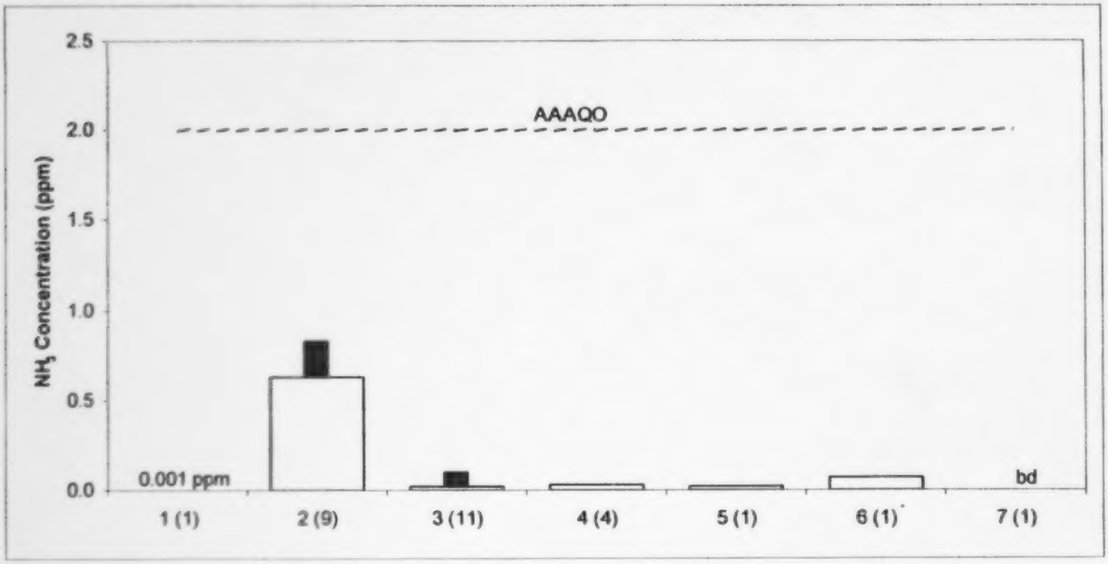

Figure 3: Median and maximum one-hour concentrations for ammonia. bd indicates concentration was below detection limit. One-hour average concentration at Site 1 was very low and thus could not be pictorially represented the figure (0.001 ppm).

Reduced sulphur compounds (TRS and H_2S)

Total reduced sulphur (TRS) includes hydrogen sulphide (H_2S) and other reduced sulphur compounds including organic sulphurs. Sulphur dioxide is not a reduced sulphur and thus not included in this group. Some industrial sources of TRS are fugitive emissions from petroleum refineries, tank farms for unrefined petroleum products, natural gas plants, petrochemical plants, oil sands plants, sewage treatment facilities, and animal feedlots. Natural sources of include sulphur hot springs, sloughs, swamps and lakes. *Alberta has a one-hour ambient air quality objective for H_2S of 0.010 ppm.*

Background TRS and H_2S concentration is typically very close to the detection limits[5] of the instrument onboard the MAML. Elevated concentrations have previously been measured along the fence line of confined feeding operations[6] and agriculture land applied with pulp mill sludge[7].

For samples taken during the current study, total reduced sulphur was almost entirely composed of H_2S. As illustrated in Figures 4 and 5, concentrations of H_2S were comparable to those of TRS. A disparity of a few parts per billion (ppb) is most probably due to differences in the instrumentation. At most sampling locations, the one-hour average TRS (and H_2S) concentrations were at or very close to instrumental detection limits. The highest concentrations were measured at **Site 3**, located north of Peterson lagoons and Lakeside wastewater treatment ponds. The median one-hour TRS and H_2S concentrations at **Site 3** were 0.003 and 0.002 ppm, respectively. The maximum one-hour average H_2S concentration of 0.012 ppm at this site exceeded the one-hour AAAQO (Figure 5). Elevated concentrations measured downwind of **Site 3** were probably due to anaerobic decomposition within the water treatment ponds and lagoons. Highest concentrations were measured when the winds were light and south-easterly putting this location directly downwind of wastewater treatment ponds and lagoons. H_2S is an odorous compound with an odour threshold of 0.0005 ppm[8], the MAML operator noted strong

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[5] 0.6 parts per billion (ppb)

[6] Air Quality report: Girouxville area confined feeding operations

[7] Air Quality report: Whitecourt area

[8] Agency for toxic substances and disease registry: Medical management for ammonia. Retrieved November 14,2006 from - Agency for toxic substances and disease registry: Medical management for ammonia. Retrieved April 13, 2007 from http://www.atsdr.cdc.go[illegible]mi/mmg114.html

odours at the time of maximum concentration (Table A4). One-hour average TRS concentrations at all other sites were less than 0.003 ppm.

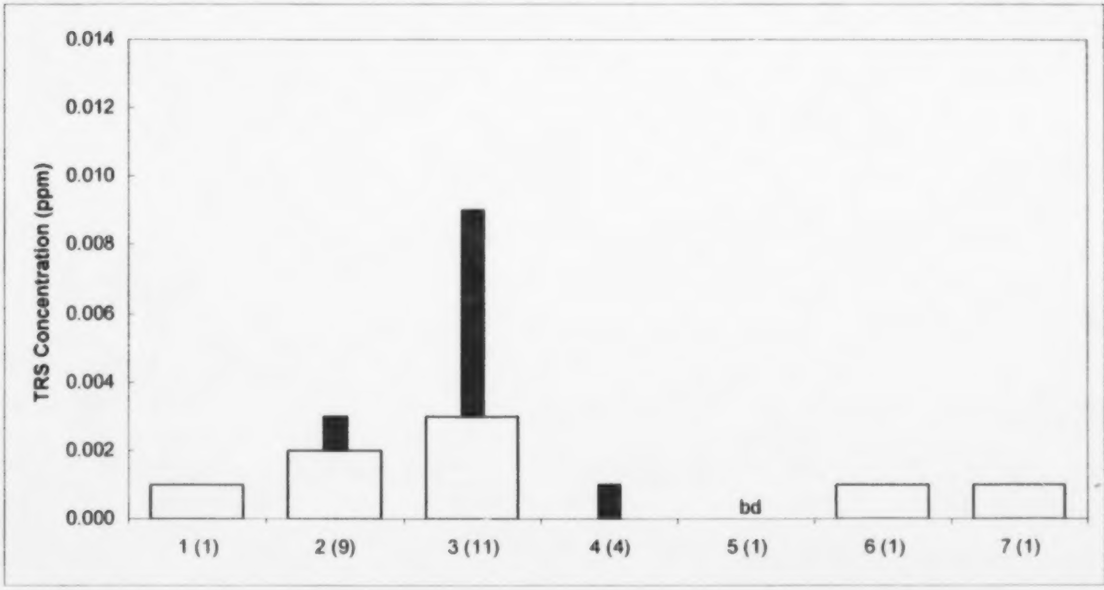

Figure 4: Median and maximum one-hour average concentrations for total reduced sulphur. bd indicates concentration was below detection limit.

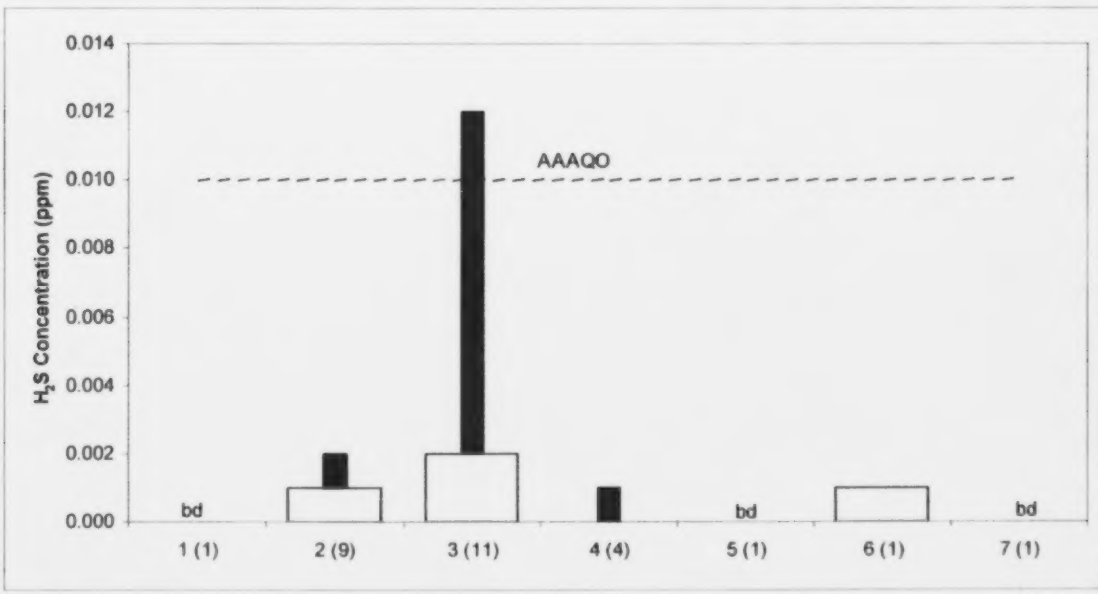

Figure 5: Median and maximum one-hour average concentrations for hydrogen sulphide. bd indicates concentration was below detection limit.

Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons (PAHs) are a class of hydrocarbons that are usually contained in soot and smoke. They are formed during the incomplete combustion of gasoline, diesel, oil, coal, wood, garbage or other organic substances. Other outdoor PAH sources include vehicle emissions, wood smoke from fireplaces, smoke from forest fires and industrial facilities. PAHs occur in the atmosphere in the vapour phase or in the condensed phase bound to particles. The instrument on the MAML will analyze **only** particle bound PAHs. PAHs usually occur as complex mixtures rather than single compounds. There are more than 100 different PAHs with varying levels of toxicity.

Background PAH concentrations at monitoring sites around Alberta are typically close to the detection limit of the instrument onboard the MAML (1 ng/m^3). The median one-hour average PAHs at the upwind site (**Site 1**) was close to background levels at 2 ng/m^3. Figure 6 presents median and maximum one-hour average PAHs concentrations measured at the MAML sites. Median concentrations at all the sites were comparable or lower than the median at **Site 1**. This indicates that overall, PAHs concentrations in the area were low.

Although the general PAHs concentrations for this study were equivalent to background levels, elevated one-hour averages were noted at **Site 4** and to some extent **Site 2**. The maximum one-hour average of 21 ng/m^3 at **Site 4** was very similar to concentrations measured during a MAML survey south of the Calder rail yard (Table A5), an area influenced by motor vehicle emissions from the Hwy 1. Elevated PAHs concentration at **Site 4** occurred concurrent to increases in NO_x levels (Table A3) and south-easterly winds (Table A4). Figure 1 illustrates that southeast of **Site 4** is Highway 1 (Trans-Canada highway). Thus, it is most likely that PAHs concentrations at this site had contributions from vehicle emissions. The maximum one-hour average at **Site 2** (7 ng/m^3) was observed at a time when there were vehicle activities on the Lakeside feedlot (Table A5). Thus, the maximum one-hour PAHs concentration at **Site 2** was also likely due to vehicle emissions.

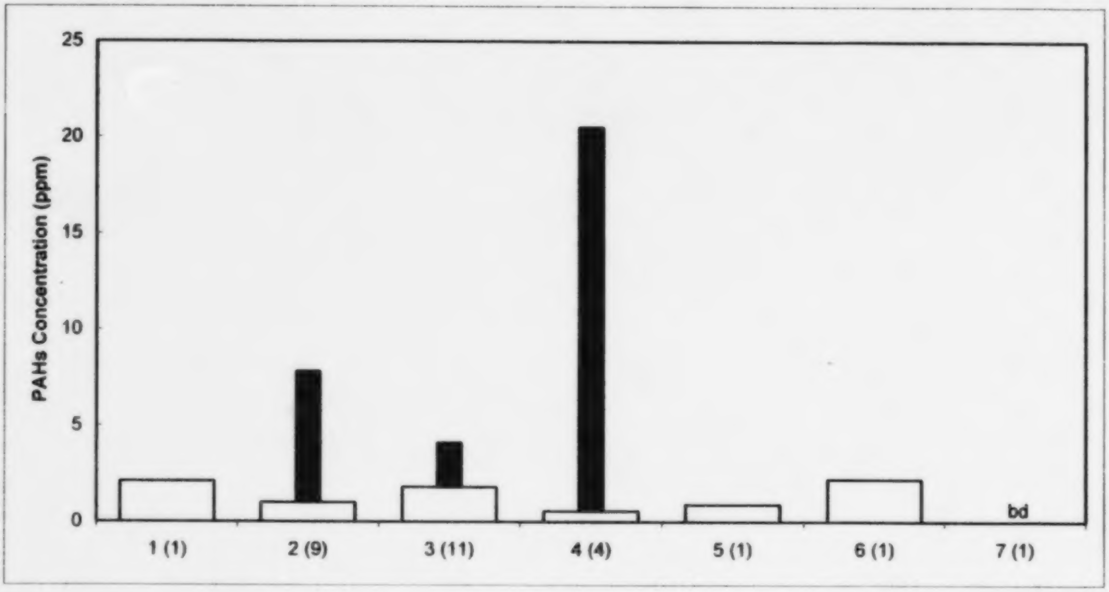

Figure 6: Median and maximum one-hour average concentrations for polycyclic aromatic hydrocarbons.

Total Hydrocarbons

The term "total hydrocarbons" (THC) refers to a broad family of chemicals that contain carbon and hydrogen atoms. The hydrocarbons referred to in this section are gaseous hydrocarbon. Methane (CH_4), a non-reactive hydrocarbon, is the most common hydrocarbon in the earth's atmosphere. As a result, for most measurements around Alberta, concentrations of THC and CH_4 are equivalent (Table A5) with a total background concentration of about 2 ppm. Reactive hydrocarbons (RHC) form the remaining fraction of THC. RHC are important because: (1) they can react with oxides of nitrogen in the presence of sunlight to form ground level ozone a component of smog; and (2) some RHC can be toxic (at high concentrations) to humans, animals or vegetation. Typically RHC concentrations measured during MAML surveys are close to instrument detection limit (0.01 ppm). The major sources of hydrocarbons in Alberta include vegetation, vehicle emissions, gasoline marketing and storage tanks, petroleum and chemical industries and fugitive emissions such as leaks and evaporation of solvents.

Figure 7 shows that THC concentrations at **Sites 4-7** were similar to background levels (2 ppm). Due to equipment failure, hydrocarbon concentrations were not measured at the upwind site (**Site 1**). Furthermore, THC was almost entirely composed of the non-reactive hydrocarbon CH_4, with median one-hour average CH_4 concentrations being almost identical to concentration of THC. Median contribution from RHC was less than 0.2 ppm (Figure 9). Note that the y-axes of Figures 7-9 are equivalent, this is done to facilitate comparison.

Somewhat elevated THC concentrations were measured at **Sites 2** and **3**. It was also at these two sites the most notable contributions from reactive hydrocarbons were detected. **Site 2** was located downwind of Lakeside feedlot and **Site 3** was located downwind of wastewater treatment ponds and lagoons. The maximum one-hour average THC concentrations at **Site 2** and **3** were 3.5 and 3.8 ppm, respectively. The maximum THC concentration at **Site 3** was measured at the same time as elevated H_2S and NH_3 concentrations; in addition to strong odours from the treatment ponds and lagoons (Table A4 and A5). Thus, hydrocarbon concentrations at **Site 3** most probably were influenced by fugitive emissions from wastewater treatment ponds and/or lagoons. The maximum one-hour average THC at **Site 2** was measured when there were no vehicle activities on the Lakeside feedlot and the one-hour average wind speed was low (<8 km/hr). Elevated hydrocarbon concentrations at **Site 2** were most likely due to fugitive emissions from the Lakeside feedlot.

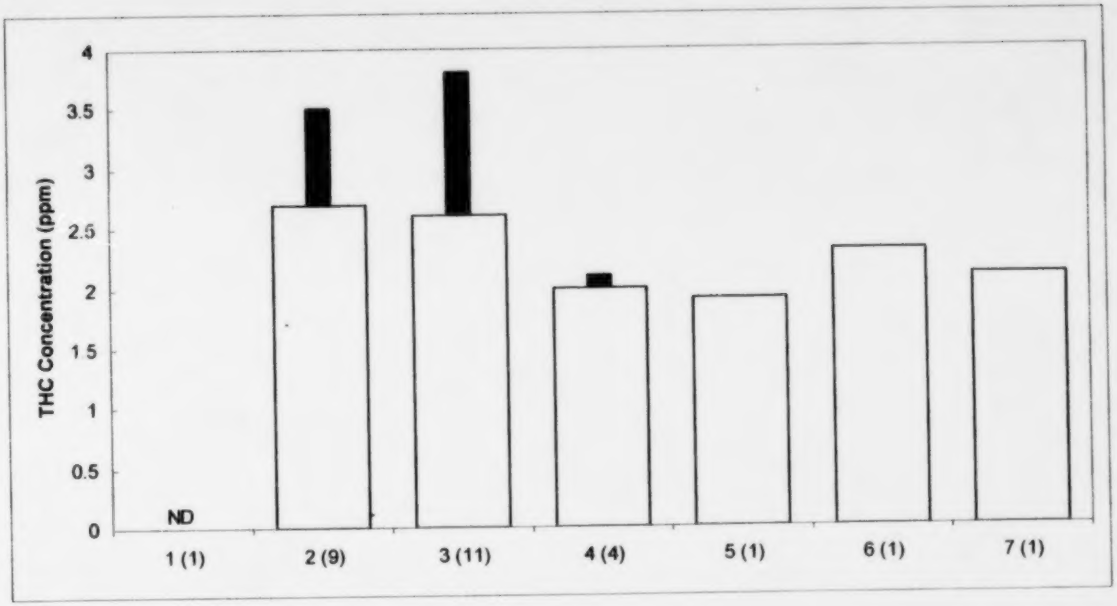

Figure 7: Median and maximum one-hour average concentrations for total hydrocarbons.

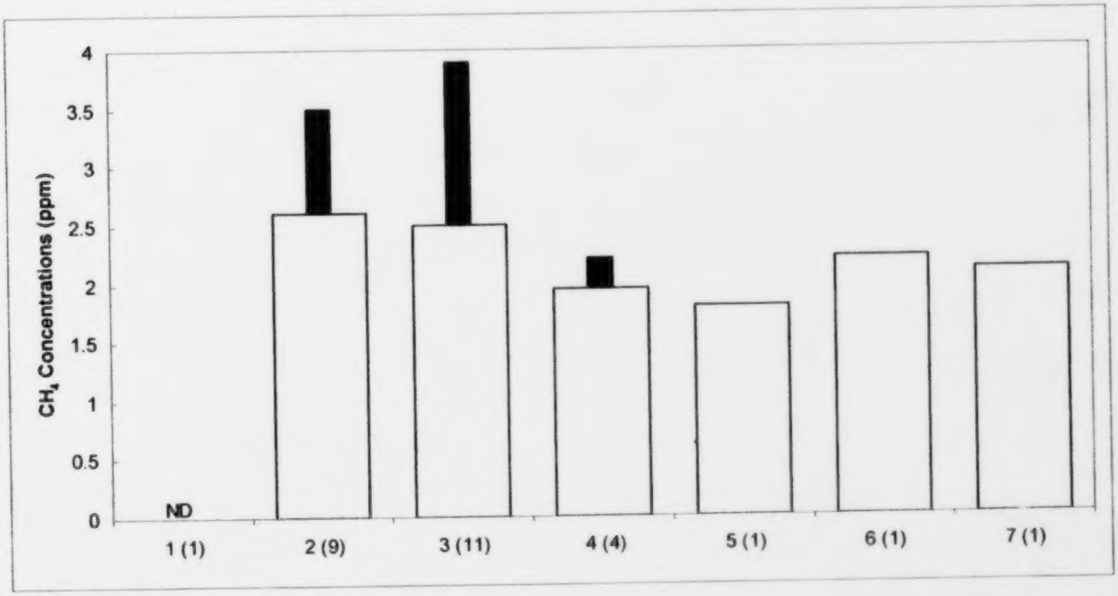

Figure 8: Median and maximum one-hour average concentrations for methane.

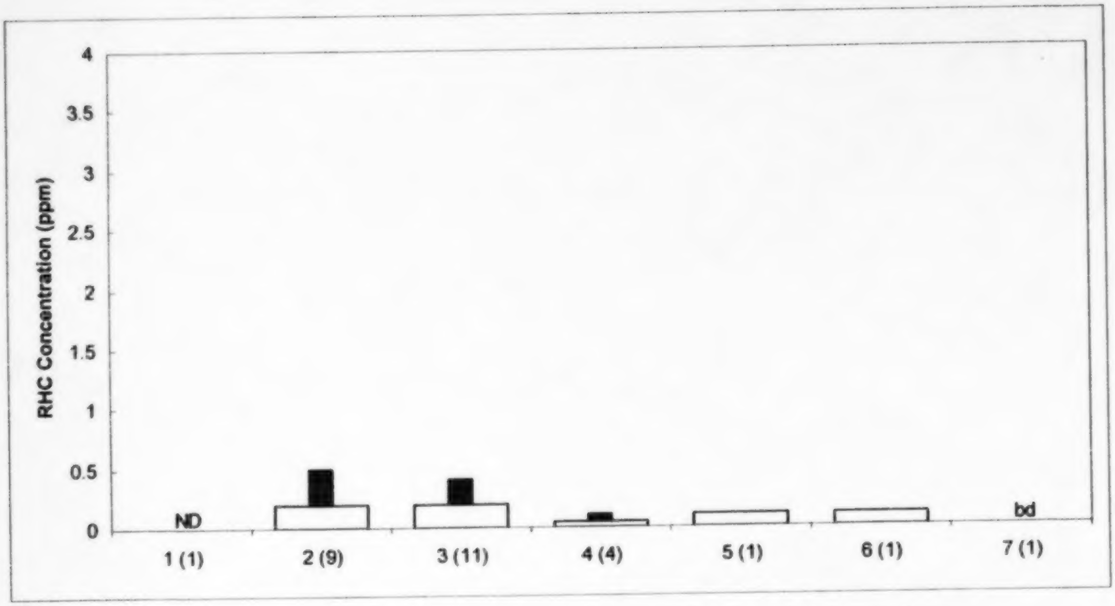

Figure 9: Median and maximum one-hour average concentrations for reactive hydrocarbons.

Particulate Matter (TSP, PM_{10} and $PM_{2.5}$)

Inhalable particulates are less than 10 micrometres (μm) in aerodynamic diameter (PM_{10}). In rural areas, sources of PM_{10} include soil dust, road dust and agricultural dust (which includes dust from harvesting and feedlot operation), smoke from forest fires and wood burning and vehicle exhaust. Respirable particulates are less than 2.5 μm in aerodynamic diameter ($PM_{2.5}$). $PM_{2.5}$ are small enough to penetrate into the lungs. Respirable particulates may be produced by the same sources as PM_{10}; in addition $PM_{2.5}$ can form in the atmosphere as gases react to form condensable products. Total suspended particles (TSP) range in size from 0.001 to 500 μm; this size range includes both PM_{10} and $PM_{2.5}$.

Particulate matter from Lakeside feedlot was of special concern to residence in the area. Three forms of particulate monitoring were performed.

1. The MAML monitored $PM_{2.5}$, PM_{10} and TSP at **Sites 1-7** (2003 survey). Samples were collected less than 2 km downwind of sources.

2. Continuous sampling of $PM_{2.5}$ using a TEOM was performed at **Sites 8** and **9** (see Table 1). These sites were setup to evaluate the extent of particulate from Lakeside feedlot further downwind (Figure1). The instrumentations were setup at nearby residences. The TEOM provided one-hour averages of $PM_{2.5}$, this data was used to determine 24-hour concentrations.

3. Intermittent filter samples provided 24-hr average concentrations of PM_{10} and TSP. These samples were collected at **Site 8** during 2003 survey.

Further descriptions of sampling methods are given in the *Monitoring Methods and Locations* section.

Particulate concentrations at Sites 1-7: MAML monitoring

The overall one-hour median particulate concentrations during this survey were the highest for MAML air quality surveys (Table A5). This is largely due to moderately elevated particulate concentrations at most of the monitoring sites. The median one-hour average TSP

concentrations ranged from 36 μg/m^3 at the upwind site (**Site 1**) to 175 μg/m^3 downwind of Lakeside feedlot (**Site 2**). The median one-hour TSP concentrations at almost all the other sites were comparable to that measured at **Site 2** (Figure 10). The exception was **Site 3** (wastewater treatment pond) where median concentration of 43 μg/m^3 was similar to the upwind monitoring site. PM_{10} and $PM_{2.5}$ concentrations showed similar levels. Note that the y-axis of Figure 11 and 12, which illustrate PM_{10} and $PM_{2.5}$ concentrations, are set equivalent to Figure 10 (TSP) to facilitate comparison. Median one-hour average PM_{10} concentrations for four out of seven sites were greater than 90 μg/m^3 (Figure 11). Median one-hour average $PM_{2.5}$ concentrations are shown in Figure 12; concentrations at more than half of the sites were greater than 10 μg/m^3. The overall particulate concentrations measured during the MAML survey may have been somewhat elevated due to relatively low precipitation observed for 2003. As will be illustrated in the following section, particulate concentrations were generally higher at for the 2003 sample period relative to 2005. Dry conditions are conducive to the re-suspension of road, soil and agriculture dust.

While re-suspended dust likely contributed to the overall particulate concentration during the 2003 survey, the maximum one-hour concentrations illustrate that concentration can be elevated downwind of selected sources. The maximum one-hour average TSP concentration of 361 μg/m^3 (**Site 2**) and 498 μg/m^3 (**Site 3**) are examples. Maximum one-hour PM_{10} and $PM_{2.5}$ at **Site 3** were also elevated relative to the median concentrations at the other sites. Elevated concentrations at **Site 3** were measured when the wind direction shifted (Table A4) such that the site was downwind of Brooks airport. Particles downwind of Lakeside feedlot had relatively small $PM_{2.5}$ contributions. Particles sampled at **Site 2** are most probably due to agriculture dust produced as a result of increased cattle activity on the Lakeside feedlot.

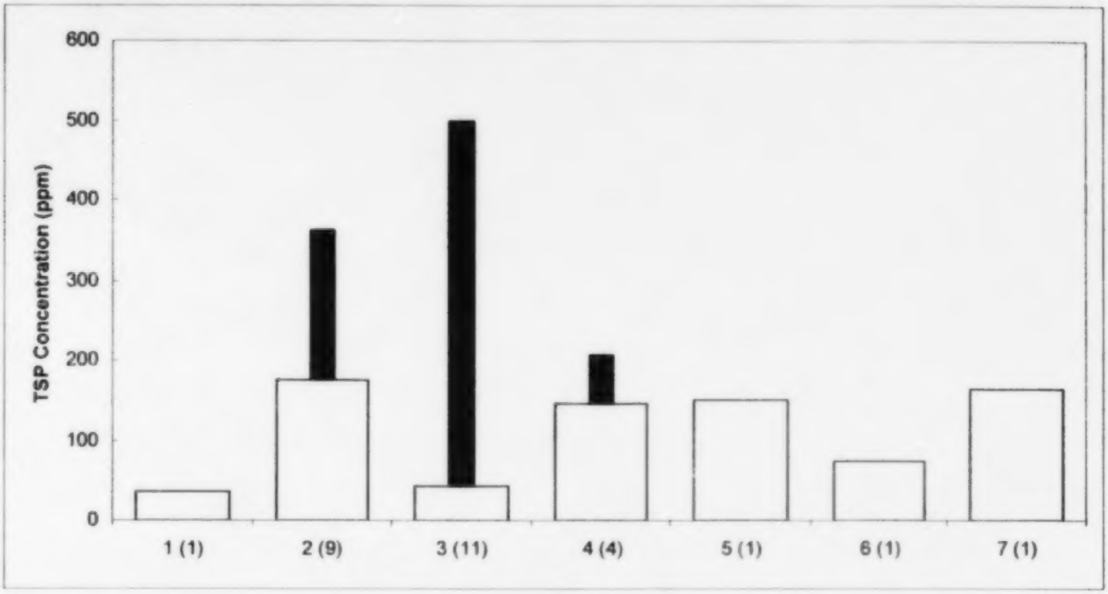

Figure 10: Median and maximum one-hour average concentrations for total suspended particles.

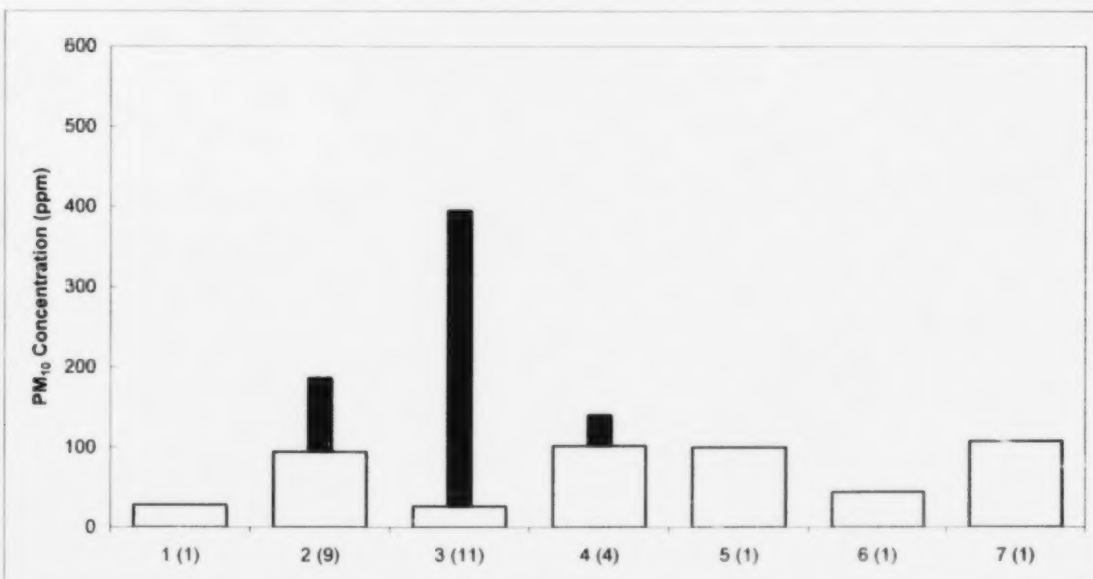

Figure 11: Median and maximum one-hour average concentrations for PM_{10}

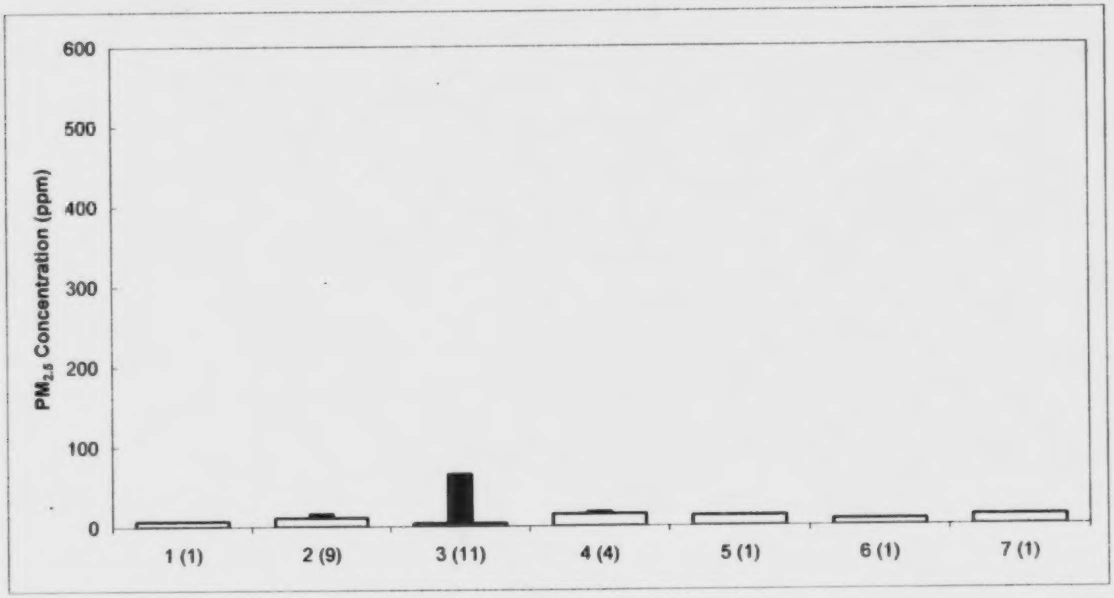

Figure 12: Median and maximum one-hour average concentrations for $PM_{2.5}$.

Particulate concentrations at Sites 8 and 9

Figures 13 and 14 show 24-hour average and 24-hour maximum concentrations determined from one-hour average concentrations at **Site 8** and **9.** Also indicated are the median 24-hour average concentrations for the 2003 and 2005 sample period. These two concentrations present a comparison for the two sample seasons. It is clearly evident from these figures that overall concentration for the 2003 sample period were higher. Note that almost all the 24-hour averages for 2003 were higher than the median for 2005 sample period. The locations of **Site 8** (2003) and **Site 9** (2005) are shown in Figure 1. The two sites were separated by a distance of 4 km, that being said both sites were located on the grounds of local residents and away from nearby sources. The most likely reason for the observed differences is the amount of precipitation. Average monthly precipitation[9] during 2003 survey was 29 mm [10] with July and August being the driest months. Conversely, average monthly precipitation for the 2005 sample period was more than two times higher at 72 mm [8].

2003 sample period

During the 2003 sample period, 24-hour average $PM_{2.5}$ concentrations between August 13th and September 8th were substantially higher than the overall 2003 median (Figure 13). There was no clear association between wind direction and concentrations measured. Figures A1 illustrates wind direction and particulate concentration information. Furthermore, for wind speeds greater than 1 km/hr, easterly winds (from the direction of Lakeside feeders) made up only 5% of the data. Elevated concentrations between August 13th and September 8th were most probably due to activities in the surrounding fields such as hay bailing.

PM_{10} and TSP were intermittently collected on filters (2003); samples were collected when feedlot odours were evident. Concentrations of PM_{10} and TSP measured during these events are shown in Figure 15 and 16. TSP concentrations for two of the samples were found to exceed the 24-hour average AAAQO (Samples D and F). Table 2 indicates the date and time when the samples were collected as well as the operator's comments. Alberta Environment does not have an ambient objective for PM_{10}. However, it is evident from Figure 16 that PM_{10}

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[9] Average monthly total precipitation rather than total precipitation was used because the two sample periods differ in length.

[10] Precipitation data obtained from Environment Canada Climate data base: http://climate.weatheroffice.ec.gc.ca/climateData/canada_e.html

concentrations were also higher for sample D and F. These two samples were taken between July 15th and 16th and July 22nd and 24th. $PM_{2.5}$ concentrations from the continuous sampler were only somewhat higher than the overall median at these times. $PM_{2.5}$ concentrations at these times were below the Canada Wide Standard benchmark concentration of 30 $\mu g/m^3$. Thus, particles sampled when feedlot odours were present mainly contribute to TSP and PM_{10}. This finding is similar to the MAML results obtained downwind of Lakeside feedlot (**Site 2**).

2005 sample period

$PM_{2.5}$ concentrations for the 2005 survey remained relatively constant, showing small variations about the median value (solid horizontal line in Figure 14). The highest concentrations (greater than 6 $\mu g/m^3$) were measured for southerly and south-westerly winds (Figure A1). To the south and southwest of **Site 9** are agriculture fields; the highest measured concentrations were most likely due activity on this land. 24-hour average $PM_{2.5}$ concentrations lower than 6 $\mu g/m^3$ showed no clear association with wind direction. The overall $PM_{2.5}$ concentrations at **Site 9** were low. However, the concentrations may have been influenced by vehicle emissions. This is clearly illustrated in the diurnal average shown in Figure 17. Peak $PM_{2.5}$ concentration was observed at about 08:00 and the afternoon increase in concentrations began shortly after 15:30, these trends are typically found for commuter traffic emissions. The diurnal trend for 2005 is notably different from that observed for 2003 (Figure 18), when concentrations were likely elevated due to increase in dust levels resulting from the relatively dry conditions. Intermittent PM_{10} and TSP samples were not collected in 2005.

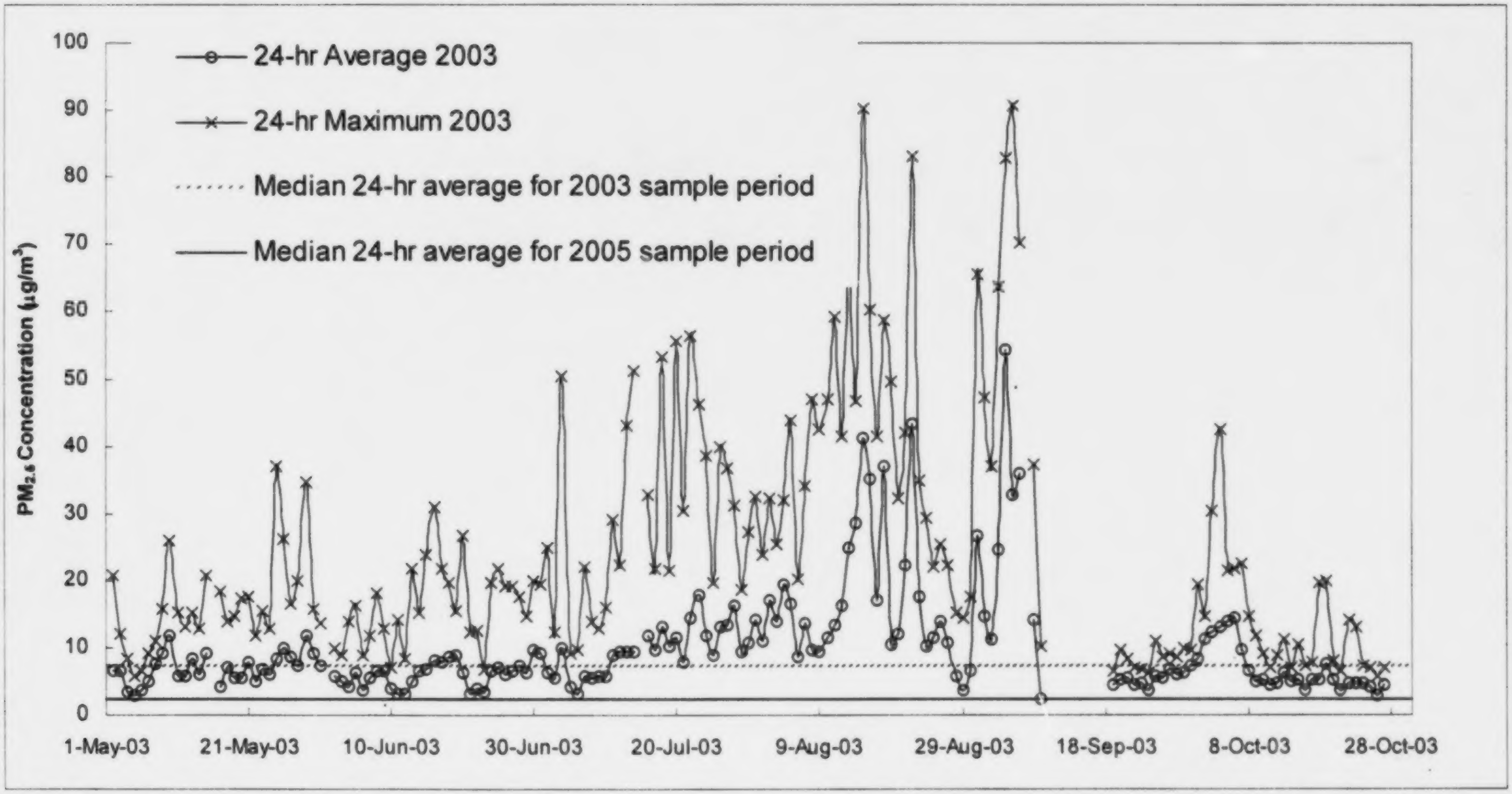

Figure 13: 24-hour average and 24-hour maximum PM2.5 concentrations at Site 8. These samples were collected during the 2003 survey. Also indicate are the median 24-hour average for 2003 and 2005. Particle concentrations were notably higher during the 2003 sample period.

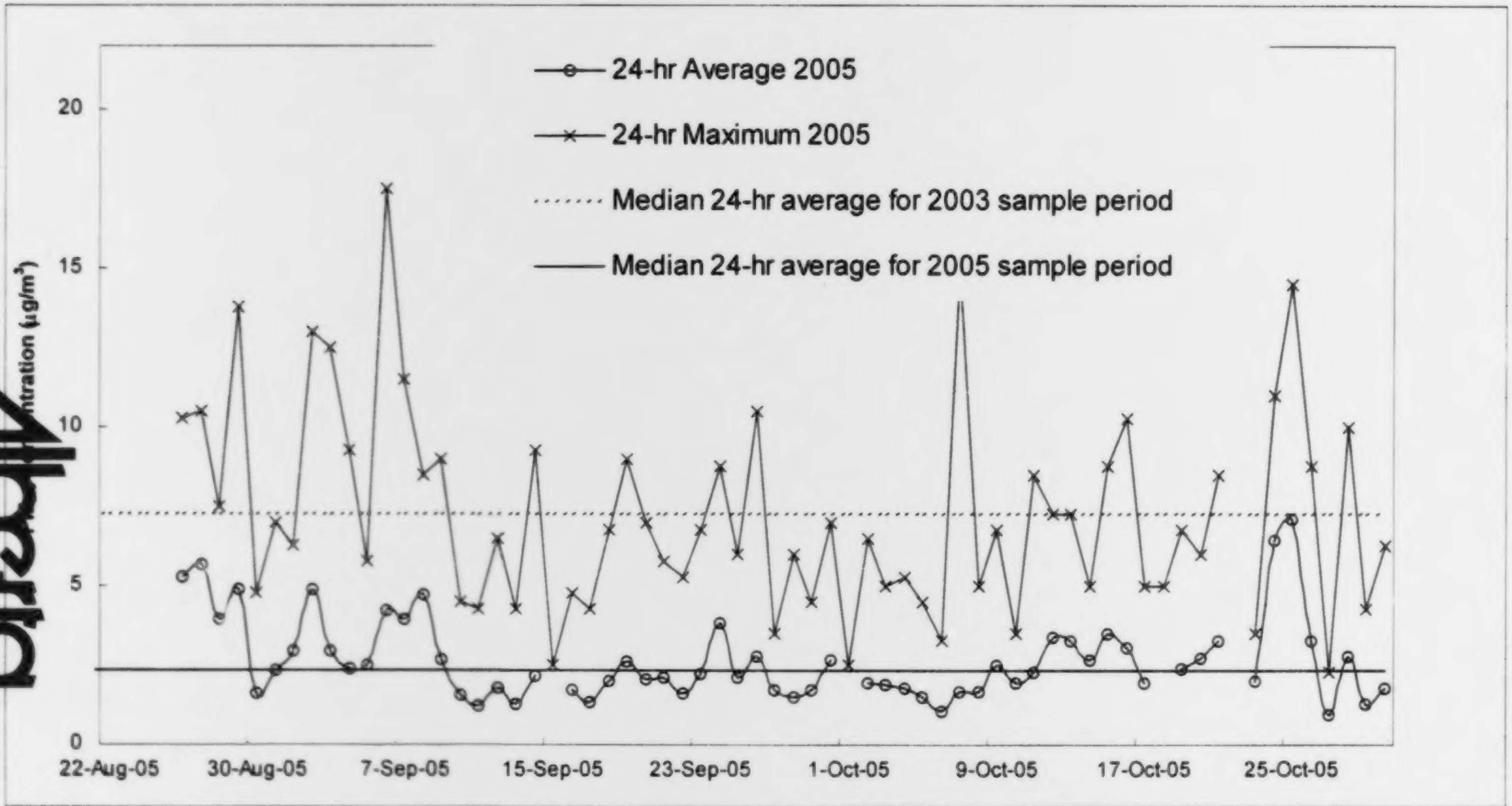

Figure 14: 24-hour average and 24-hour maximum PM2.5 concentrations at Site 9. These samples were collected during the 2005 survey. Also indicate are the median 24-hour average for 2003 and 2005.

Table 2: Intermittent filter samples start and end times and operator's comments

Sample	*Start time*	*End time*	*Operator's comments*
A	04/06/2003 22:05	05/06/2003 22:03	Odours evident only for the first 1/2 hr of sample time, wind direction for the remainder of the time not from the feedlot
B	04/06/2003 19:42	05/07/2003 20:10	Odours evident for several hours
C	07/06/2003 21:20	08/07/2003 22:59	Odours not intense but evident throughout the night
D	15/06/2003 20:45	16/07/2003 21:02	Odours throughout the night
E	18/06/2003 21:23	20/07/2003 9:01	Sampling period longer than 24hr
F	22/06/2003 19:46	24/07/2003 7:32	Still night, fog present
G	23/08/2003 20:01	24/08/2003 21:08	Odours evident for approximately 2 hours
H	22/10/2003 8:32	23/10/2003 7:52	Odours evident for short time at the start of sample

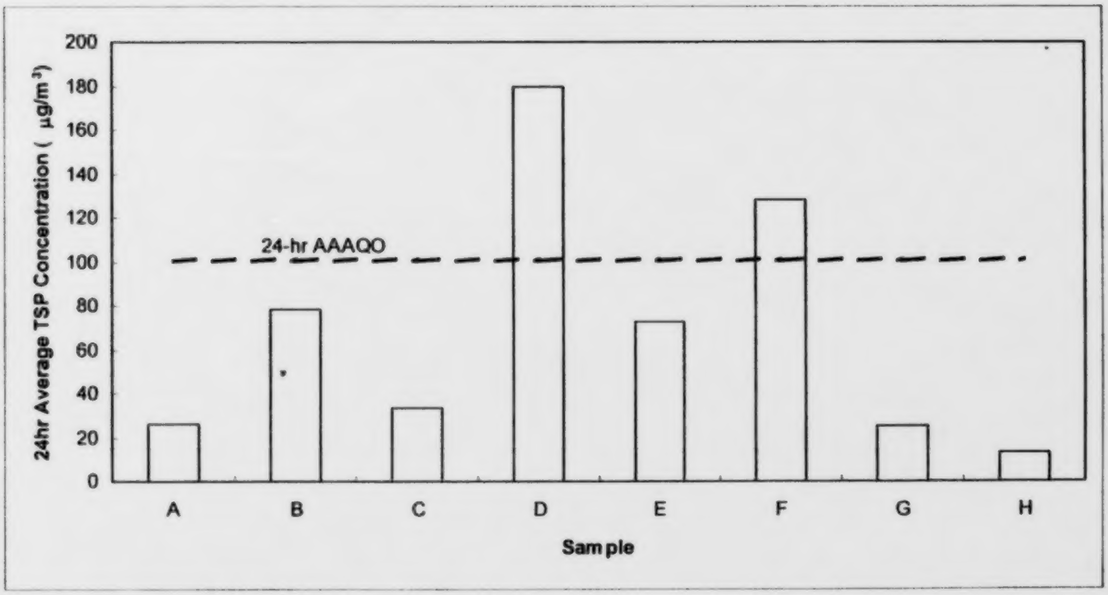

Figure 15: 24-hour average TSP concentrations measured at Site 8. The letters indicate different samples (see Table 2).

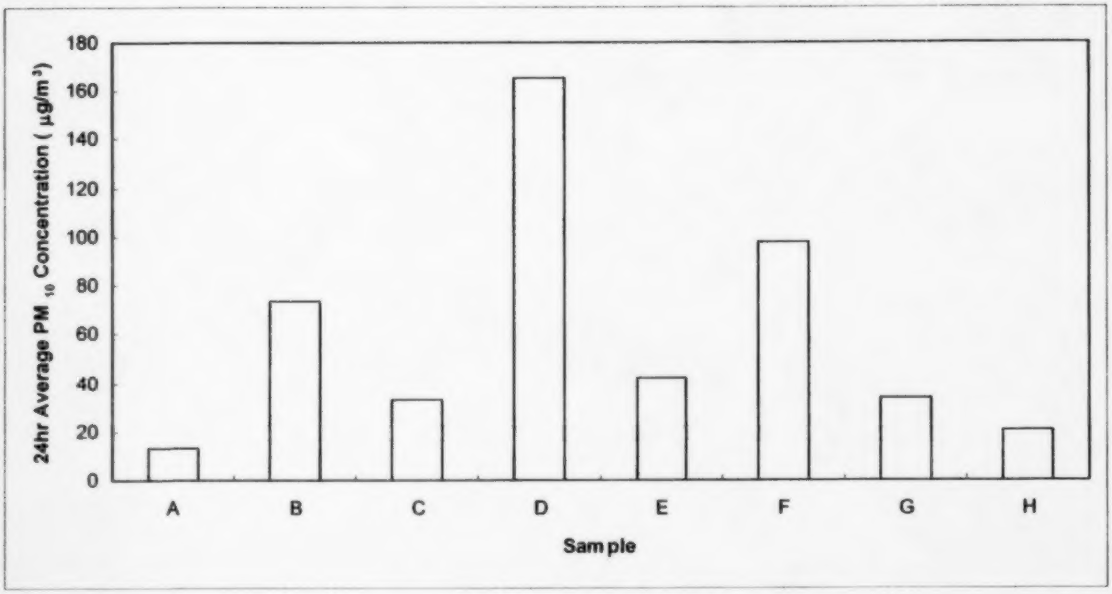

Figure 16: 24-hour average PM_{10} concentrations measured at Site 9. The letters indicate different samples (see Table 2).

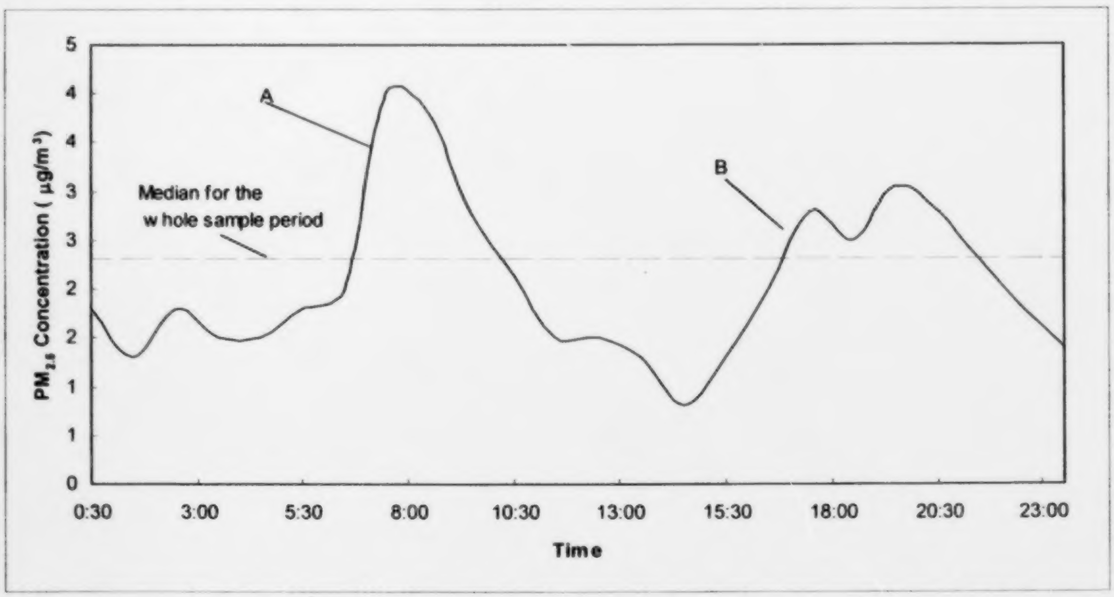

Figure 17: Diurnal trend for $PM_{2.5}$ at Site 9 (2005). Although concentrations were low, there was evidence of vehicle emission influence (A and B).

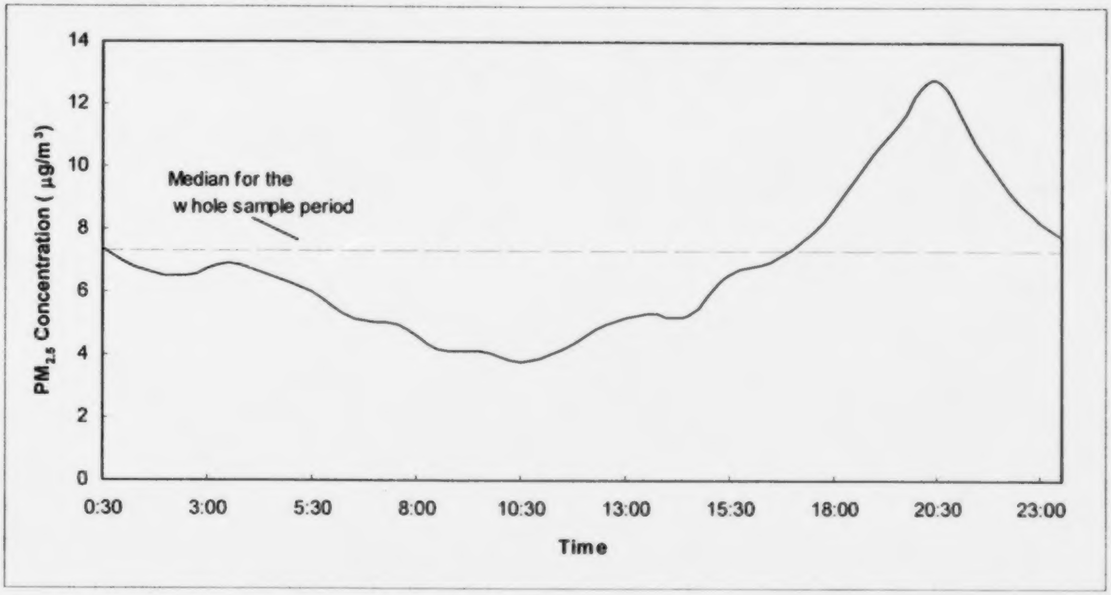

Figure 18: Diurnal trend for $PM_{2.5}$at Site 8 (2003)

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Appendix A

Table A1: Median one-hour concentrations for various monitoring locations

Site#	CO PPM	O_3 PPM	THC PPM	CH_4 PPM	RHC PPM	SO_2 PPM	NO PPM	NO_2 PPM	NO_x PPM	NH_3 PPM	TRS PPM	H_2S PPM	TSP $\mu g/m^3$	PM_{10} $\mu g/m^3$	$PM_{2.5}$ $\mu g/m^3$	PAH ng/m^3
1(1)	0.1	0.056	ND	ND	ND	0.001	0.001	bd	bd	0.001	0.001	ND	36	28	7	2
2(9)	0.2	0.039	2.7	2.6	0.2	bd	0.005	0.002	0.005	0.627	0.002	0.001	175	94	11	1
3(11)	0.1	0.038	2.6	2.5	0.2	0.001	0.002	0.003	0.005	0.018	0.003	0.002	43	26	4	2
4(4)	0.1	0.034	2.0	2.0	0.1	0.001	0.003	0.005	0.008	0.028	0.001	bd	147	102	15	1
5(1)	bd	0.042	1.9	1.8	0.1	0.001	0.002	0.003	0.005	0.022	bd	bd	150	100	13	1
6(1)	bd	0.018	2.3	2.2	0.1	0.002	0.010	0.011	0.020	0.068	0.001	0.001	74	44	8	2
7(1)	bd	0.041	2.1	2.1	bd	0.001	0.001	0.004	0.004	bd	0.001	bd	165	107	12	bd

Table A2: Maximum one-hour concentrations for various monitoring locations

Site#	CO PPM	O_3 PPM	THC PPM	CH_4 PPM	RHC PPM	SO_2 PPM	NO PPM	NO_2 PPM	NO_x PPM	NH_3 PPM	TRS PPM	H_2S PPM	TSP $\mu g/m^3$	PM_{10} $\mu g/m^3$	$PM_{2.5}$ $\mu g/m^3$	PAH ng/m^3
[illegible]	0.1	0.056	ND	ND	ND	0.001	0.001	ND	ND	0.001	0.001	ND	36	28	7	2
2(9)	0.4	0.053	3.5	3.5	0.5	0.001	0.016	0.012	0.025	0.829	0.003	0.002	361	186	16	8
3(11)	0.3	0.047	3.8	3.9	0.4	0.001	0.007	0.008	0.014	0.096	0.009	0.012	498	395	65	4
4(4)	0.3	0.044	2.1	2.2	0.1	0.002	0.053	0.024	0.076	0.034	0.001	0.001	207	140	18	21
5(1)	bd	0.042	1.9	1.8	0.1	0.001	0.002	0.003	0.005	0.022	bd	bd	150	100	13	1
(1)	bd	0.018	2.3	2.2	0.1	0.002	0.010	0.011	0.020	0.068	0.001	0.001	74	44	8	2
7(1)	bd	0.041	2.1	2.1	bd	0.001	0.001	0.004	0.004	bd	0.001	bd	165	107	12	bd

Notes:

- numbers in brackets indicate number of hours of monitoring at the site

ppm - parts per million **ng/m³** - nanograms per cubic meter **µg/m³** - micrograms per cubic meter

bd - below detection limit of analyzer **ND** - no data indicates that the analyzer was not operational

Table A3: One-hour average concentration at each of the monitoring sites

Date	Time	Site	Facility	CO PPM	O_3 PPM	THC PPM	CH_4 PPM	RHC PPM	SO_2 PPM	NO PPM	NO_2 PPM	NO_x PPM	NH_3 PPM	TRS PPM	H_2S PPM	TSP $\mu g/m^3$	PM_{10} $\mu g/m^3$	$PM_{2.5}$ $\mu g/m^3$	PAH ng/m^3
9-Jul	13:55 to 14:55	1	Upwind	0.1	0.056	ND	ND	ND	0.001	0.001	bd	bd	0.001	0.001	ND	36	28	7	2
	15:27 to 16:27	2	Lakeside feedlot	0.1	0.052	3.2	2.7	0.5	bd	0.002	0.002	0.005	0.495	0.002	0.002	137	77	9	7
	16:27 to 17:27	2	Lakeside feedlot	0.1	0.053	3.2	2.9	0.4	bd	0.001	0.002	0.004	0.437	0.002	0.001	118	66	8	2
10-Jul	07:48 to 08:48	2	Lakeside feedlot	0.2	0.025	2.6	2.6	0.1	bd	0.011	0.007	0.016	0.667	0.001	0.001	248	126	11	8
	11:39 to 12:39	2	Lakeside feedlot	0.4	0.038	2.5	2.4	0.2	bd	0.005	0.002	0.005	0.746	0.002	0.001	223	119	11	1
	12:39 to 13:39	2	Lakeside feedlot	0.4	0.038	2.6	2.4	0.2	bd	0.005	0.002	0.005	0.727	0.002	0.001	175	94	9	1
	13:39 to 14:39	2	Lakeside feedlot	0.4	0.039	2.7	2.5	0.2	bd	0.005	0.003	0.006	0.829	0.003	0.001	221	118	11	1
	14:39 to 15:39	2	Lakeside feedlot	0.3	0.042	2.4	2.3	0.1	bd	0.004	0.002	0.004	0.627	0.002	0.001	130	70	7	1
	15:57 to 16:57	3	Wastewater treatment lagoons	0.2	0.046	1.7	1.6	bd	bd	bd	0.000	bd	0.028	bd	bd	10	8	1	bd
	16:57 to 17:57	3	Wastewater treatment lagoons	0.1	0.047	1.7	1.7	bd	bd	bd	0.001	bd	0.013	bd	bd	3	2	bd	bd
	18:08 to 19:08	2	Lakeside feedlot	0.1	0.042	3.5	3.2	0.3	0.001	0.003	0.003	0.005	0.572	0.003	0.001	361	186	16	bd
11-Jul	07:49 to 08:49	3	Wastewater treatment lagoons	0.1	0.031	3.1	2.9	0.3	0.001	0.006	0.005	0.010	0.021	0.006	0.005	44	32	7	3
	08:52 to 09:52	3	Wastewater treatment lagoons	0.1	0.037	2.7	2.5	0.3	0.001	0.004	0.003	0.005	0.018	0.003	0.002	12	7	1	2
	09:52 to 10:52	3	Wastewater treatment lagoons	0.1	0.041	2.3	2.1	0.2	0.001	0.003	0.002	0.003	0.009	0.001	bd	8	5	1	1
	11:27 to 12:27	3	Wastewater treatment lagoons	0.3	0.046	2.1	1.8	0.4	bd	0.002	0.001	0.002	0.009	bd	bd	9	7	2	bd
30-Sep	14:49 to 15:50	7	Irrigation pivot	bd	0.041	2.1	2.1	bd	0.001	0.001	0.004	0.004	0.000	0.001	bd	165	107	12	bd
	16:03 to 17:06	3	Wastewater treatment lagoons	0.1	0.040	2.8	2.9	0.1	0.001	0.001	0.003	0.004	0.042	0.004	0.004	166	120	18	2
	17:11 to 18:13	4	Lakeside feedlot	0.3	0.016	2.1	2.2	bd	0.002	0.053	0.024	0.076	0.022	0.001	0.001	164	115	17	21
1-Oct	08:26 to 09:26	3	Wastewater treatment lagoons	0.1	0.019	2.7	2.7	0.2	0.001	0.007	0.007	0.014	0.004	0.006	0.004	296	179	23	4
	09:26 to 10:26	3	Wastewater treatment lagoons	0.1	0.023	2.6	2.5	0.2	0.001	0.005	0.007	0.012	0.004	0.005	0.003	43	26	4	2
	11:18 to 12:19	4	Lakeside feedlot	0.1	0.031	2.1	2.0	0.1	0.001	0.004	0.006	0.010	0.033	bd	bd	130	88	13	1
	12:19 to 13:18	4	Lakeside feedlot	0.1	0.037	1.9	1.9	bd	0.001	0.002	0.004	0.005	0.034	bd	bd	67	45	6	bd
	13:43 to 14:44	5	Martin feedlot	bd	0.042	1.9	1.8	0.1	0.001	0.002	0.003	0.005	0.022	bd	bd	150	100	13	1
	15:04 to 16:05	4	Lakeside feedlot	bd	0.044	1.9	1.8	0.1	0.001	bd	0.002	0.002	0.018	0.001	bd	207	140	18	1
	16:09 to 17:09	3	Wastewater treatment lagoons	0.0	0.038	3.8	3.9	0.1	0.001	0.002	0.005	0.007	0.096	0.009	0.012	63	44	6	3
	17:09 to 18:05	3	Wastewater treatment lagoons	0.1	0.026	1.9	1.9	bd	0.001	0.001	0.008	0.008	0.061	bd	bd	498	395	65	2
2-Oct	07:18 to 08:20	2	Lakeside feedlot	0.1	0.011	3.4	3.5	0.1	0.001	0.016	0.012	0.025	0.532	0.002	0.002	167	92	13	5
	08:32 to 09:36	6	Lakeside and martin feedlot	bd	0.018	2.3	2.2	0.1	0.002	0.010	0.011	0.020	0.068	0.001	0.001	74	44	8	2

Notes:

ppm – parts per million **$\mu g/m^3$** – micrograms per meter cubed **ng/m^3** – nanograms per meter cubed
ND – no data, indicates that the analyzer was not operational for the indicated period **bd** – below detection limit

Table A4: Weather conditions and operator's comments.

Date	Time	Site	Facility	Comments	Temp DegC	RH %RH	WSP KPH	WDR
	13:55 to 14:55	1	Upwind	Entrance to Paul Seaton res. LSD SE16-19-15 W4 Elevated particulate from road dust	26.7	29.0	11.1	WSW
	15:27 to 16:27	2	Lakeside feedlot	Stop at Twp Rd 192 and Rge Rd 151, 20m from Lakeside feedlot fencline. Elevated particulate from feedlot and trucks on the lot	27.7	27.0	10.6	W
9-Jul	16:27 to 17:27	2	Lakeside feedlot	Stop at Twp Rd 192 and Rge Rd 151, 20m from Lakeside feedlot fencline. Elevated particulate from feedlot and trucks on the lot	27.3	26.8	13.2	NW
	07:48 to 08:48	2	Lakeside feedlot	Stop at Twp Rd 192 and Rge Rd 151, 20m from feedlot fenceline and facing north. Particulate and NH3 from feedlot	21.5	48.9	9.7	WNW
	11:39 to 12:39	2	Lakeside feedlot	Stop at Twp Rd 192 and Rge Rd 151, 20m from feedlot fenceline and facing north.	26.0	32.9	12.0	W
	12:39 to 13:39	2	Lakeside feedlot	Particulate and NH3 from feedlot. Dust contributed by truck operations on site	26.3	31.9	12.5	W
	13:39 to 14:39	2	Lakeside feedlot	Particulate and NH3 from feedlot. Dust contributed by truck operations on site	27.6	29.6	11.5	WNW
	14:39 to 15:39	2	Lakeside feedlot	Particulate and NH3 from feedlot. Dust contributed by truck operations on site	27.2	29.3	13.0	W
	15:57 to 16:57	3	Wastewater treatment lagoons	Stop 250m west of Rge Rd 150 on Twp Rd 194 downwind of South Airport Pivot. Pivot is 300m NW of MAML Spraying but no odours	26.6	28.7	16.6	SW
	16:57 to 17:57	3	Wastewater treatment lagoons	Stop 250m west of Rge Rd 150 on Twp Rd 194 downwind of South Airport Pivot. Pivot is 300m NW of MAML Spraying but no odours	26.6	27.9	13.1	SSE
10-Jul	18:08 to 19:08	2	Lakeside feedlot	Stop at Twp Rd 192 and Rge Rd 151, 20m from feedlot fenceline and facing north. Test to see if absence of trucks on feedlot make any difference in particulate levels	26.9	30.7	7.9	SSE
	07:49 to 08:49	3	Wastewater treatment lagoons	Downwind and 1/2 mile north of Lakeside Wastewater Treatment. N & S Peterson lagoon and pivot are also downwind. Pivot is not operating.	22.5	48.9	14.5	S
	08:52 to 09:52	3	Wastewater treatment lagoons	Downwind and 1/2 mile north of Lakeside Wastewater Treatment.	23.7	46.7	13.4	S
	09:52 to 10:52	3	Wastewater treatment lagoons	Downwind and 1/2 mile north of Lakeside Wastewater Treatment.	25.9	41.9	13.0	S
11-Jul	11:27 to 12:27	3	Wastewater treatment lagoons	Stop 500m east of Rge Rd 150 on Twp Rd 194 1/2 mile straight north of Lakeside Packers.	27.8	33.6	13.0	SSE

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Alberta ENVIRONMENT

Table A4: Meteorological conditions* and operator's comments (continued from the previous page).

Date	Time	Site	Facility	Comments	Temp DegC	RH %RH	WSP KPH	WDR
	14:49 to 15:50	7	Irrigation pivot	Downwind of North Eastern Irrigation District (EID) pivot. Pivot active, slight odours (not feedlot odour)	18.8	29.0	11.3	S
	16:03 to 17:06	3	Wastewater treatment lagoons	1 mile north & downwind of packing plant ponds, odours from ponds. Particulates from gravel road vehicles	18.0	31.0	11.6	SSE
30-Sep	17:11 to 18:13	4	Lakeside feedlot	1 mile north of feedlot on Hwy 1 at Twp Rd 194. Strong feedlot odours	15.2	37.9	4.4	SSE
	08:26 to 09:26	3	Wastewater treatment lagoons	Twp Rd 194 & Rge Rd 150 downwind of ponds, dust due to passing trucks	9.9	57.4	14.0	S
	09:26 to 10:26	3	Wastewater treatment lagoons		13.3	47.4	14.9	S
	11:18 to 12:19	4	Lakeside feedlot	Hwy #1 & Twp Rd 194. Downwind of feedlot, feedlot odours evident.	18.6	34.4	14.1	SSE
	12:19 to 13:18	4	Lakeside feedlot		21.5	27.2	16.5	SSE
	13:43 to 14:44	5	Martin feedlot	1/4 mile north and downwind of small feedlot next to town, feedlot odours	22.6	24.5	13.8	S
	15:04 to 16:05	4	Lakeside feedlot	Feedlot odours	22.0	25.0	12.7	SE
	16:09 to 17:09	3	Wastewater treatment lagoons	Twp Rd 194 & Rge Rd 150 downwind of ponds. Strong odours from ponds	23.0	27.0	8.5	SE
1-Oct	17:09 to 18:05	3	Wastewater treatment lagoons	Wind shifted to easterly in second hour	18.9	36.8	5.2	ESE
	07:18 to 08:20	2	Lakeside feedlot	Stop along road on southside of Lakeside feedlot. Odours evident from feedlot	8.0	73.1	13.1	NW
2-Oct	08:32 to 09:36	6	Lakeside and martin feedlot	Stop in Brooks a NW edge of new development Upland Ave 1km south of small feedlot. Downwind of Martin Farms and Lakeside feedlot. Odour less intense than first spot of the day	13.4	54.0	9.3	SW

Notes:

* - Meteorological conditions were measured at monitoring sites

Temp - Temperature in degrees centigrade **RH** - Relative humidity in percentage **WSP KPH** - Wind speed in Km/hr

WDR - Wind direction

Table A5: Median one-hour concentrations for selected MAML surveys and permanent monitoring stations.

Station or Survey Type	Air Quality Station or Survey Name	Monitoring Period	CO ppm	O_3 ppm	THC ppm	CH_4 ppm	RHC ppm	SO_2 ppm	NO_2 ppm	NH_3 ppm	TRS ppm	H_2S ppm	TSP µg/m³	PM_{10} µg/m³	$PM_{2.5}$ µg/m³	PAH ng/m³
mobile	Brooks[1] (Current study)	July, Sept, Oct 2003	0.1	0.038	2.5	2.4	0.1	0.001	0.003	0.033	0.001	0.001	130	77	9	1
mobile	Calder Yards[1]	Feb, Sept, Aug 2004 & Feb, Mar 2005	0.7	0.010	2.7	2.5	0.3	0.002	0.033	0.008	0.001	0.001	43	28	4	20
mobile	Caroline[1]	Oct 05 & Jan, May, Jun 06	0.2	0.038	1.8	1.8	bd	0.002	0.004	0.003	0.001	0.001	79	49	6	1
mobile	Girouxville[1]	Fall 2004, spring 2005, 2006	0.3	0.028	2.1	2.1	bd	0.001	0.001	0.013	0.002	0.001	21	15	2	bd
mobile	Whitecourt[1]	Sep. 6 - 7, 2005	0.2	0.027	2.1	2.1	bd	0.001	0.002	0.084	0.001	0.001	28	16	2	1
mobile	Lloydminster[1]	Jan. 2002 to Nov. 2004	0.2	0.030	2.5	2.2	0.2	0.001	0.006	0.001	0.001	bd	19	13	2	3
mobile	Lakeland Area[1]	May 2003 to Sep. 2004	0.2	0.031	2.6	2.4	0.2	bd	0.002	0.002	bd	bd	14	9	1	bd
mobile	Banff[1]	Nov. 19 - 23, 2003	0.5	0.018	2.7	2.5	0.2	bd	0.008	0.004	bd	0.001	7	5	1	11
mobile	Fort Saskatchewan/Redwater[1]	May 2001 to Mar. 2002	0.3	0.029	2.1	2.1	0.1	0.001	0.004	0.001	bd	bd	39	22	3	bd
mobile	Cold Lake/Bonnyville/Elk Point[1]	Mar. 2001 to Feb. 2002	0.2	0.031	2.1	1.9	0.1	bd	0.003	0.000	0.001	bd	16	10	2	1
mobile	Whitecourt/Swan Hills/Shiningbank Lake[1]	Mar. 2001 to Jun. 2001	0.2	0.027	2.3	2.0	0.3	0.004	0.005	0.001	0.001	bd	47	29	4	1
mobile	Wabamun[1]	Jul. 2000 to Sep. 2001	0.2	0.027	2.0	1.9	0.1	0.002	0.005	0.004	bd	bd	34	22	3	1
mobile	Edmonton Whitemud Drive	Jun. 2000 to Jul. 2001	0.4	0.019	2.2	2.0	0.1	0.002	0.014	bd	bd	bd	41	24	3	8
Permanent Continuous Monitoring Stations																
urban	Calgary Central[2]	Jan. 2005 to Dec. 2005	0.4	0.014	2.0	n/a	n/a	n/a	0.022	n/a	n/a	n/a	n/a	19	4	n/a
urban	Edmonton Central[2]	Jan. 2005 to Dec. 2005	0.4	0.015	2.0	n/a	n/a	n/a	0.019	n/a	n/a	n/a	n/a	n/a	4	n/a
small urban	Fort Saskatchewan[3]	Jan. 2005 to Dec. 2005	0.2	0.02	1.9	n/a	n/a	0.001	0.008	0.001	n/a	bd	n/a	n/a	3	n/a
small urban	Red Deer[3]	Jan. 2005 to Dec. 2005	0.2	0.02	2.0	n/a	n/a	bd	0.01	n/a	n/a	bd	n/a	n/a	3	n/a
rural	Beaverlodge[3]	Jan. 2005 to Dec. 2005	n/a	0.028	n/a	n/a	n/a	bd	0.003	n/a	n/a	n/a	n/a	n/a	2	n/a
rural	Fort Chipewyan[3]	Jan. 2005 to Dec. 2005	n/a	0.026	n/a	n/a	n/a	bd	bd	n/a	n/a	n/a	n/a	n/a	1	n/a
industrial	Buffalo Viewpoint[3]	Jan. 2005 to Dec. 2005	n/a	n/a	1.9	n/a	n/a	bd	n/a	n/a	n/a	bd	n/a	n/a	n/a	n/a
industrial	Mannix[3]	Jan. 2005 to Dec. 2005	n/a	n/a	1.9	n/a	n/a	0.001	n/a	n/a	n/a	bd	n/a	n/a	n/a	n/a
industrial	Mildred Lake[3]	Jan. 2005 to Dec. 2005	n/a	n/a	1.8	n/a	n/a	bd	n/a	n/a	n/a	bd	n/a	n/a	n/a	n/a

Notes:

ppm – parts per million **µg/m³** – micrograms per meter cubed **ng/m³** – nanograms per meter cubed

bd – below detection limit **n/a** – parameter not monitored or data not available

1 – Mobile survey conducted by Alberta Environment.

2 – Station operated by Alberta Environment.

3 – Station operated Airsheds.

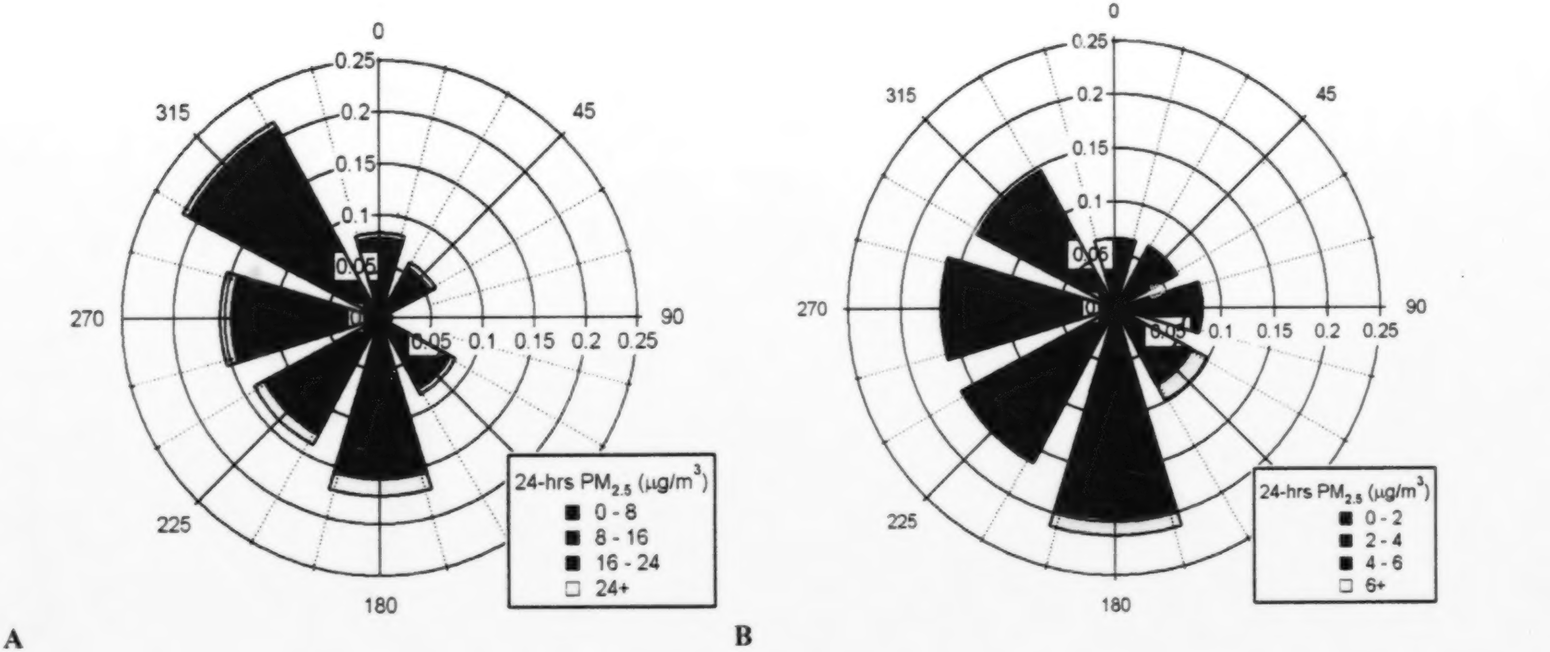

Figure A1: Wind direction and particle concentrations for 2003 (A) and 2005 (B) sample period.

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Appendix B

Alberta's Ambient Air Quality Objectives

Alberta's Ambient Air Quality Objectives[1] are established under Section 14 of the Environmental Protection and Enhancement Act (EPEA , R.S.A. 2000, c.E-12, as amended). EPEA provides for the development of environmental objectives for Alberta.
The Ambient Air Quality Objectives are used for:

- Reporting on the state of the atmospheric environment in Alberta.
- Reporting to Albertans on the quality of the air through Alberta's Air Quality Index (AQI).
- Establishing approval conditions for regulated industrial facilities.
- Evaluating proposals to construct facilities that will have air emissions.
- Guiding special ambient air quality surveys.
- Assessing compliance near major industrial air emission sources.

Some of Alberta's Ambient Air Quality Objectives are based on odour perception. This is the case for ammonia, nitrogen dioxide and hydrogen sulphide. For these chemicals, people are likely to detect an odour at concentrations well below levels that may affect human health. Alberta's Ambient Air Quality Objectives for one-hour average concentration of pollutants monitored by the MAML are listed in Table B1.

Table B1: Alberta's Ambient Air Quality Objective measured by the MAML

Pollutant	One-hour AAAQO (ppm*)	Basis for Objective
Ammonia	2	odour perception
Carbon monoxide	13	oxygen carrying capacity of blood
Nitrogen dioxide	0.212	odour perception
Ozone	0.082	reduction of lung function and effects on vegetation
Hydrogen sulphide	0.01	odour perception
Sulphur dioxide	0.172	pulmonary function

* parts per million

[1] *Alberta Ambient Air Quality Objectives*. Alberta Environment. April 2005.

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Alberta's Ambient Air Quality Objectives

Alberta's Ambient Air Quality Objectives[1] are established under Section 14 of the Environmental Protection and Enhancement Act (EPEA , R.S.A. 2000, c.E-12, as amended). EPEA provides for the development of environmental objectives for Alberta.
The Ambient Air Quality Objectives are used for:

- Reporting on the state of the atmospheric environment in Alberta.
- Reporting to Albertans on the quality of the air through Alberta's Air Quality Index (AQI).
- Establishing approval conditions for regulated industrial facilities.
- Evaluating proposals to construct facilities that will have air emissions.
- Guiding special ambient air quality surveys.
- Assessing compliance near major industrial air emission sources.

Some of Alberta's Ambient Air Quality Objectives are based on odour perception. This is the case for ammonia, nitrogen dioxide and hydrogen sulphide. For these chemicals, people are likely to detect an odour at concentrations well below levels that may affect human health. Alberta's Ambient Air Quality Objectives for one-hour average concentration of pollutants monitored by the MAML are listed in Table B1.

Table B1: Alberta's Ambient Air Quality Objective measured by the MAML

[illegible]	[illegible]	Basis for Objective
[illegible]	2	odour perception
[illegible]	13	oxygen carrying capacity of blood
[illegible]	0.212	odour perception
[illegible]	0.082	reduction of lung function and effects on vegetation
[illegible]	0.01	odour perception
[illegible]	0.172	pulmonary function

* parts per million

[1] *Alberta Ambient Air Quality Objectives.* Alberta Environment. April 2005.

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The median concentration

The median concentration is a common way of representing the central value for environmental data. Most environmental data usually consist of a distribution that is skewed to the right; that is most data values are low and only a few are high. For such data sets, the arithmetic mean will be biased by the high concentrations; the resulting value may not be representative of the central value for the data set. For example, a data distribution consisting of five numbers: 1, 2, 2, 3 and 10. The arithmetic mean of these data is 3.6 and the median is 2. In this case, the arithmetic mean is biased high by the extreme value of 10. The median is the middlemost value in the data set; thus more representative of the central value of the data distribution. Fifty percent of the values in the dataset are below the median and fifty percent are above.

The Mobile Air Monitoring Laboratory (MAML)

The MAML is a 27-foot (8.2 m) vehicle that has been specially designed and equipped to measure air quality. It houses a variety of instruments that continuously sample the air at specified time or distance intervals. The MAML is equipped with:

- a dual computer system custom-programmed to accept and record the measurement of air samples from each analyser,
- a GPS (Global Positioning System) that identifies the MAML's location as it moves around Alberta,
- an exhaust purifying system that minimizes emissions from the vehicle and
- two on-board generators that are also equipped with exhaust scrubbers

Table B2 lists the pollutants and meteorological data monitored by the MAML. Also indicated are the lower and upper detection limits for each monitored species.

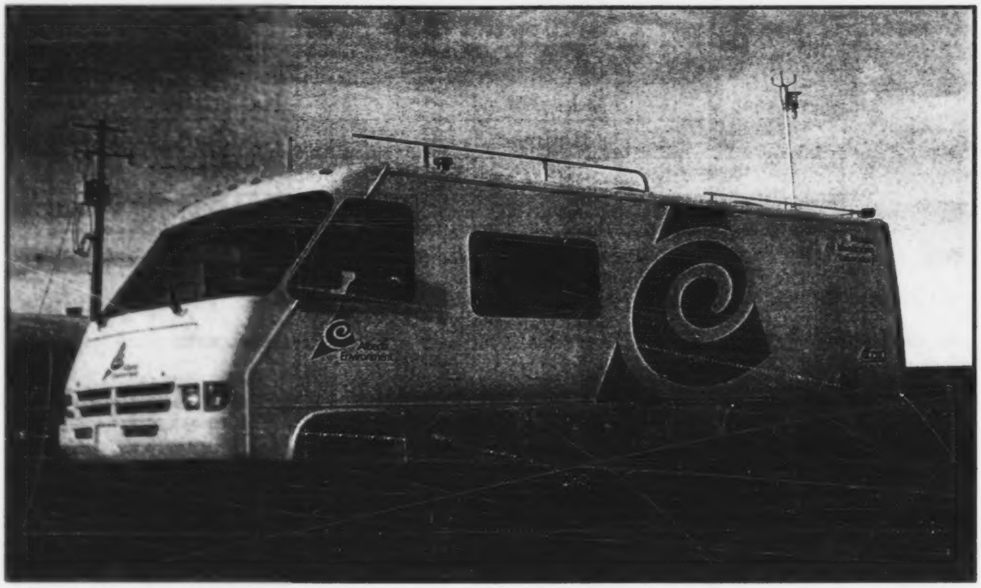

Figure B1: Alberta Environment's Mobile Air Monitoring Laboratory

Table B2: Pollutants and meteorological data monitoring by the MAML.

Pollutant	Operating Range	
	Lower Detection Limit*	Upper Detection Limit**
Ammonia **(NH_3)**	0.001 ppm	5 ppm
Ozone **(O_3)**	0.001 ppm	0.5 ppm
Carbon Monoxide **(CO)**	0.1 ppm	50 ppm
Hydrocarbons		
Methane **(CH_4)**	0.1 ppm	20 ppm
Reactive Hydrocarbons **(RHC)**	0.1 ppm	20 ppm
Total Hydrocarbons **(THC)**	0.1 ppm	20 ppm
Polycyclic Aromatic Hydrocarbons **(PAH)**	3 ng/m^3	1000 ng/m^3
Oxides of nitrogen		
Nitrogen dioxide **(NO_2)**	0.0006 ppm	1 ppm
Nitric Oxide **(NO)**	0.0006 ppm	1 ppm
Oxides of nitrogen **(NO_x)**	0.0006 ppm	1 ppm
Particulate Matter		
Total Suspended Particulates **(TSP)**	1 $\mu g/m^3$	1.0 g/m^3
Particulate Matter <10μm **(PM_{10})**	1 $\mu g/m^3$	1.0 g/m^3
Particulate Matter <2.5μm **($PM_{2.5}$)**	1 $\mu g/m^3$	1.0 g/m^3
Sulphur Compounds		
Hydrogen Sulphide **(H_2S)**	0.001 ppm	1 ppm
Total Reduced Sulphur **(TRS)**	0.001 ppm	1 ppm
Sulphur Dioxide **(SO_2)**	0.001 ppm	2 ppm
Meteorological data		
Wind Speed	0 km/hr	200 km/hr
Wind Direction	0 degrees	360 degrees
Temperature	-40 °C	50 °C
Relative humidity	0%	100%

ppm = parts per million

ng/m^3 = nanograms per meter cubed

$\mu g/m^3$ = micrograms per cubic meter

g/m^3 = grams per meter cubed

* The ***lower detection limit*** indicates the *minimum* amount of pollutant and the lower limit of meteorological data can be measured by the instrument.

** The ***upper detection limit*** indicates the *maximum* amount of pollutant the instrument can detect and the upper limit for meteorological data measured. This limit is set to provide the optimum precision over that range. The upper limit can be raised, however, precision at the lower levels (where most levels are monitored) is then compromised.

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Table B2: Pollutants and meteorological data monitoring by the MAML.

Lower Detection Limit*	Upper Detection Limit**
0.001 ppm	5 ppm
0.001 ppm	0.5 ppm
0.1 ppm	50 ppm
0.1 ppm	20 ppm
0.1 ppm	20 ppm
0.1 ppm	20 ppm
3 ng/m^3	1000 ng/m^3
0.0006 ppm	1 ppm
0.0006 ppm	1 ppm
0.0006 ppm	1 ppm
1 $\mu g/m^3$	1.0 g/m^3
1 $\mu g/m^3$	1.0 g/m^3
1 $\mu g/m^3$	1.0 g/m^3
0.001 ppm	1 ppm
0.001 ppm	1 ppm
0.001 ppm	2 ppm
0 km/hr	200 km/hr
0 degrees	360 degrees
-40 °C	50 °C
0%	100%

ppm - parts per million

ng/m^3 = nanograms per meter cubed

$\mu g/m^3$ = micrograms per cubic meter

g/m^3 = grams per meter cubed

* The ***lower detection limit*** indicates the *minimum* amount of pollutant and the lower limit of meteorological data can be measured by the instrument.

** The ***upper detection limit*** indicates the *maximum* amount of pollutant the instrument can detect and the upper limit for meteorological data measured. This limit is set to provide the optimum precision over that range. The upper limit can be raised, however, precision at the lower levels (where most levels are monitored) is then compromised.

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